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Dated: September 7, 2007 Signature: (Marco Jimenez)

OIPE IAP35 SEP 07 2007 PATENT & TRADEMARK OFFICE

Docket No.: 393032039700
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Katsuichi OSAKABE

Application No.: 10/626,141

Confirmation No.: 9326

Filed: July 24, 2003

Art Unit: 2627

For: OPTICAL DISK RECORDING APPARATUS CONTROLLABLE BY TABLE OF MULTI-PULSE PATTERNS

Examiner: P. H. Gupta

CLAIM FOR PRIORITY AND SUBMISSION OF DOCUMENTS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicant hereby claims priority under 35 U.S.C. 119 based on the following prior foreign application filed in the following foreign country on the date indicated:

Country	Application No.	Date
Japan	2002-216991	July 25, 2002

In support of this claim, a certified copy of the said original foreign application is filed herewith.

Dated: September 7, 2007

Respectfully submitted,

By

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DECLARATION

I Harutoshi Suzuki, of 3-6-5 Fujigaoka, Fujisawa-shi, Kanagawa-ken, 251-0004 Japan, declare that I am a Patent Agent and conversant with the Japanese and English languages and that the accompanying translation, which was prepared by me, is a true translation of Japanese Patent Application No. Tokugan 2002-216991.

Signed this 30th day of May, 2007

Harutoshi Suzuki

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application:	July 25, 2002
Application Number:	Tokugan 2002-216991
[ST.10/C]:	[JP2002-216991]
Applicant(s):	YAMAHA CORPORATION

May 23, 2003

Commissioner, Shinichiro OTA

Japan Patent Office

Proof No. 2003-3037978

[Document] Patent Application

[Docket No.] 20020278

[Filing Date] July 25, 2002

[Addressee] Commissioner of Patent Office

[I.P.C.] G11B 7/0045

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[Name] Hisao KOMORI

[Indication of fees]

[Account No] 013550

[Amount] 21000

[List of attachments]

[Item]	Specification	1
[Item]	Drawings	1
[Item]	Abstract	1
[Power of Attorney]		9001567

[Proof] Requested

[Name of Document] SPECIFICATION

[TITLE OF THE INVENTION] Optical Disk Recording Apparatus

[CLAIMS]

[CLAIM 1] An optical disk recording apparatus which forms pits on a recording surface of an optical disk by applying a laser light as an intermittent multi-pulse, the apparatus comprising:

a write strategy circuit which controls turning on and off of the laser light in a multi-pulse pattern corresponding to a pit length to be formed;

storage means for storing plural kinds of multi-pulse pattern tables comprising a plurality of multi-pulse patterns corresponding to a plurality of pit lengths; and

control means for selecting one multi-pulse pattern table on the basis of one or both of a recording speed and a type of optical disk, and reading the selected multi-pulse pattern table from the storage means to set it in the write strategy circuit.

[CLAIM 2] The optical disk recording apparatus according to claim 1, wherein the multi-pulse pattern table is made by combining a plurality of multi-pulse patterns for deciding cycles on which the laser light turns on and off so as to form pits having predetermined lengths, in accordance with the respective pit lengths; and

the storage means stores a plurality of multi-pulse pattern tables each on different cycles of turning on and off.

[CLAIM 3] The optical disk recording apparatus

according to claim 2, wherein the storage means stores a 1T multi-pulse pattern table in which the laser light is turned on and off on about a 1T cycle, and a 2T multi-pulse pattern table in which the laser light is turned on and off on about a 2T cycle.

[CLAIM 4] The optical disk recording apparatus according to claim 1, claim 2 or claim 3, characterized in that the control means monitors a change in the recording speed during recording, selects the multi-pulse pattern table corresponding to the changed recording speed, and sets the selected multi-pulse pattern table in the write strategy circuit.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD OF THE INVENTION]

The present invention relates to an optical disk recording apparatus and, more particularly, to an improvement of write control (write strategy) of a CD-RW drive.

[0002]

[PRIOR ART]

In a CD-RW, a phase-change material is used for a recording layer, and when heated and then rapidly cooled, the phase-change material is phase-changed from a crystalline state to an amorphous state to form pits. In addition, when the phase-change material is heated and gradually cooled, the pits phase-changed into the amorphous state are returned to the crystalline state to thereby accomplish erasing.

The crystalline and amorphous states are different in reflectivity by about 15 percent, which thus enables record/erase of information.

[0003]

The recording layer is heated by applying a laser light, but in this case, there exists a disadvantage that, during writing, the rapid cooling is not satisfactorily achieved when a high power (write power) laser light is continuously applied and the recording layer that has been made amorphous once is turned again to the crystalline state, resulting in failure to form the pits. Now, write control (write strategy) of the CD-RW is performed, as shown in FIG. 7(A), by a multi-pulse method in which a laser light of write power is intermittently applied in a pulse manner and the power level is lowered to bottom power between pulses to help the recording layer be cooled down rapidly.

[0004]

A conventional CD-RW drive employs such a 1T multi-pulse write strategy that one cycle of a pulse (pulse width + pulse interval) corresponds to one clock (1T) of EFM.

Furthermore, in cooling the recording layer, the current of a semiconductor laser is not completely cut off but is made to flow at bottom power so that a rise to the next write power may be promptly performed. In addition, for overwrite, portions where the pits are not formed (portions which become lands) are irradiated with a laser light of erase power to erase the old pits.

[0005]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

On the other hand, with a writing speed into the CD-RW becoming higher, 10 times to 24 times writing speed is required. When writing is performed at 24 times speed, a temporal length for 1T is about 9.6 nS. In the meantime, times needed for the semiconductor laser to turn on (a rise from bottom power to write power) and to turn off (a fall from write power to bottom power) are both about 2 nS. Therefore, when the write strategy for 1T multi-pulse is performed at 24 times speed to rise a pulse of 0.5T, the pulse finishes before laser power rises as shown in FIG. 7(B), which thus causes a problem that good pits can not be formed.

[0006]

One possible idea to cope with this is to make a pulse cycle longer, but when the pulse cycle is made longer than 1T, a bit length might not synchronize with the pulse cycle, which means, for example, that a 3T-pit can not be formed on a 2T-cycle, thus leading to a problem that a simple multi-pulse train does not allow pits having a correct length to be formed. Further, another problem is that the write strategy of the multi-pulse on a long pulse cycle does not enable pits having a good shape to be formed at about 1 to 10 times low recording speed.

[0007]

An object of this invention is to provide an optical disk recording apparatus capable of forming good pits on an

optical disk such as a CD-RW both in low speed recording and high speed recording.

[0008]

[MEANS OF SOLVING THE PROBLEMS]

The invention in claim 1 is characterized in that an optical disk recording apparatus which forms pits on a recording surface of an optical disk by applying a laser light as an intermittent multi-pulse comprises: a write strategy circuit which controls turning on and off of the laser light in a multi-pulse pattern corresponding to a pit length to be formed; storage means for storing plural kinds of multi-pulse pattern tables comprising a plurality of multi-pulse patterns corresponding to a plurality of pit lengths; and control means for selecting one multi-pulse pattern table on the basis of one or both of a recording speed and a type of optical disk, and reading the selected multi-pulse pattern table from the storage means to set in the write strategy circuit.

[0009]

The invention in claim 2 is characterized in that the multi-pulse pattern table is made by combining a plurality of multi-pulse patterns for deciding cycles on which the laser light turns on and off so as to form pits having predetermined lengths, in accordance with the respective pit lengths; and the storage means stores a plurality of multi-pulse pattern tables each on different cycles of turning on and off.

The invention in claim 3 is characterized in that the storage means stores a 1T multi-pulse pattern table in which the laser light is turned on and off on about a 1T cycle, and a 2T multi-pulse pattern table in which the laser light is turned on and off on about a 2T cycle.

The invention in claim 4 is characterized in that the control means monitors a change in the recording speed during recording, selects the multi-pulse pattern table corresponding to the changed recording speed, and sets the selected multi-pulse pattern table in the write strategy circuit.

[0010]

In this invention, heating and rapid cooling are repeated by intermittently applying a laser light shorter than pits to be formed as a multi-pulse, thereby forming pits having a predetermined length on the recording surface of the optical disk. A pulse width which is a heating period for applying the laser light with write power and a pulse interval which is a cooling period for turning off the laser light with bottom power are combined to decide a multi-pulse pattern in which pits having a desired length are formed for each pit length (3T to 11T in the case of EFM of a CD), thereby forming a multi-pulse pattern table. A plurality of multi-pulse pattern tables each having different patterns is produced to be stored in the storage means. When pits are formed on an optical disk, that is, when information is recorded, one is selected from the above plurality of multi-

pulse pattern tables on the basis of one or both conditions: a type of optical disk, and a recording speed at which information is recorded on this optical disk. This means that a multi-pulse pattern may be selected in which the best pits are formed in accordance with this media type and recording speed. By recording information in this multi-pulse pattern, it is possible to produce a recorded optical disk having a good recording quality.

[0011]

It should be noted that in a recording method such as CAV, partial CAV or zone CLV where the recording speed (linear velocity) is changed during recording, the control means may monitor a change in the recording speed during recording and change the selection of the multi-pulse pattern table in accordance with the change in the recording speed. In other words, when the selection of the multi-pulse pattern table is switched in accordance with the change in the recording speed, a multi-pulse pattern table thus newly selected is read from the storage means to be set in the write strategy circuit. In this way, it is always possible to record information (form pits) by means of an optimum write strategy even in the recording method where the recording speed is changed.

[0012]

[MODE FOR CARRYING OUT THE INVENTION]

An optical disk recording apparatus in accordance with an embodiment of this invention will be described in

reference to the drawings. A CD-RW drive which writes and erases data in and from a CD-RW will be described as an example in this embodiment.

FIG. 1 is a schematic block diagram of the CD-RW drive. A disk 20, which is a CD-RW, is rotated at a predetermined rotation speed by a spindle motor 9. An optical system 1 faces a recording surface of the disk 20. The optical system 1 has a built-in semiconductor laser. This semiconductor laser emits light with predetermined power and in a predetermined multi-pulse pattern under the control of an ALPC (Automatic Lasor Power Controller) 2, a write strategy circuit 3 and an encoder/decoder 4, and irradiates the recording surface of the disk 20 with the laser light.

[0013]

A servo control circuit 7 controls the rotation speed of the spindle motor 9, a position in a radial direction of the disk of the optical system 1, and a focus of the laser light. More specifically, the servo control circuit 7 comprises a spindle (rotation) servo circuit, a tracking servo circuit, a feed servo circuit and a focusing servo circuit, and the servo circuits each control the spindle motor 9, a tracking actuator (not shown), a feed motor (not shown) and a focusing actuator (not shown).

[0014]

Data to be written into the disk 20, which is the CD-RW, is input to the encoder/decoder 4 via an interface 10. When the data to be written is input from the interface 10,

the encoder/decoder 4 adds EDC/ECC and applies CIRC processing to the data, and further applies EFM modulation to input the data into the write strategy circuit 3. The multi-pulse pattern table for forming pits with each pit length (3T to 11T) of the EFM modulated-data is set in the write strategy circuit 3. When the EFM modulated-data is input from the encoder/decoder 4, write strategy processing is performed on the basis of the multi-pulse pattern table so as to form 3T to 11T pits/lands of the EFM data, and a laser power control signal to control power levels of write power, bottom power and erase power is output. The ALPC 2 controls a current to be input to a semiconductor laser diode so that the semiconductor lasers each emit light with predetermined powers correspondingly to the laser power control signal. The actual power levels of the write power, bottom power and erase power are each controlled properly on the basis of the recording speed, OPC and the like.

[0015]

In addition, temporal lengths of pit lengths of 3T to 11T change in accordance with (in inverse proportion to) the recording speed, and the write strategy circuit 3 extends and shortens a time axis of the multi-pulse pattern on the basis of recording speed information input from a control section 5 so that the pulse width and pulse interval correspond to the recording speed.

[0016]

When the disk 20 is set on the apparatus, attribute

information of this disk 20 is read by preloading, and a disk type identification section 8 identifies the type of disk on the basis of the attribute information. The disk type is then input to the control section 5. Also, various kinds of commands are input to the control section 5 from a host device via the interface 10. When a recording command is input to the control section 5, the control section 5 decides a write strategy on the basis of recording speed determination information contained in the recording command and of the disk type detected by preloading, that is, selects a multi-pulse pattern table and reads the multi-pulse pattern table from a memory 6 to set it in the write strategy circuit 3. Also, OPC is performed immediately before recording, and an optimum value of the write power is obtained, which is then set in the ALPC 2.

[0017]

After this, data to be recorded is input from the interface 10, and then the data is put in an EFFM form so as to be recorded in the disk 20.

[0018]

Here, the memory 6 stores plural kinds of multi-pulse pattern tables. The multi-pulse pattern tables are as shown in FIG. 2 and FIG. 3. Patterns having an optimum pulse width and pulse interval to form pits of 3T to 11T are set in the multi-pulse pattern tables, and multi-pulse patterns each based on different pulse cycles (pulse width + pulse interval) are stored in the respective multi-pulse pattern

tables. FIG. 2 shows a 1T multi-pulse pattern table (1T cycle write strategy) on a basic cycle of 1T, and FIG. 3 shows a 2T multi-pulse pattern table (2T cycle write strategy) on a basic cycle of 2T.

[0019]

In the multi-pulse patterns based on the 1T cycle shown in FIG. 2, about the same cycle patterns are used to form pits having any length. In other words, such a pattern is repeated in which the laser is turned on during a first 1T period, and then turned off (bottom power) for 0.5T, and turned on (write power) for 0.5T. After the laser is turned off for 0.6T only during the last 1T period, transition is made to the erase power 0.4T before the end of a pit section.

[0020]

Furthermore, the same is applied to the multi-pulse pattern based on the 2T cycle shown in FIG. 3 in that the laser is turned on for a first 1T (1.1T only in 3T pits) in all the pit lengths, but after that, the pulse interval and pulse width are formed in various patterns in conformity to the respective pit lengths. Since the basic pulse cycle is longer than 1T, the cycle might not correspond in some pit lengths. Therefore, various pulse widths and pulse intervals are used so that all the pits of 3T to 11T can be formed accurately. For example, when 3T pits are formed, the laser is first turned on (write power) in a pulse width of 1.1T, and then turned off (bottom power) only for 1.0T. After that (although 0.9T remains before 3T ends), control is performed

with erase power. By controlling a bottom power section and erase power section in this way, remaining heat in a write power section is controlled so that the 3T pits will be formed.

[0021]

FIG. 4 is a flowchart showing a basic operation of the control section 5. In accordance with this operation shown, one of the 1T multi-pulse pattern table or 2T multi-pulse pattern table is selected on the basis of the recording speed and disk type. When the blank disk 20 which is a CD-RW is set on the apparatus (s1), the type of disk is identified by preloading (s2), which is retained in an internal memory of the control section 5. The control section 5 is on standby until a recording command is input from a host device connected via the interface 10. When the recording command is input (s3), one of the 1T multi-pulse pattern table or 2T multi-pulse pattern table is selected on the basis of the recording speed determination information contained in the recording command and the disk type identified during the preload (s4), and the selected multi-pulse pattern table is read from the memory 6, which is then set in the write strategy circuit 3 (s5).

[0022]

After that, when data to be recorded is input via the interface 10, the encoder/decoder 4 adds EDC/ECC and applies CIRC processing to the data, and also applies EFM modulation to the data to input it to the write strategy

circuit 3. On the basis of the multi-pulse pattern table set by the control section 5, the write strategy circuit 3 generates a laser power control signal to form pits/lands having a length corresponding to EFM-encoded data input from the encoder/decoder 4, so as to input the signal to the ALPC 2. On the basis of the laser power control signal input from the write strategy circuit 3, the ALPC 2 controls the light emission of the semiconductor laser of the optical system 1 by means of the optimum laser power in accordance with the disk type, recording speed and results of the OPC of that time. In this way, pits are formed on the disk 20, and the data input via the interface 10 is recorded.

[0023]

The CD-RWs which are recordable optical disks each have different attribute information (disk type information) because of a difference in characteristics among manufactures, but the disk types of CD-RWs are generally classified into low speed media for recording at 1 to 4 times speed, high speed media for recording at 4 to 16 times speed and ultra speed media for recording at 8 to 32 times speed.

[0024]

In selecting one of the 1T multi-pulse pattern table or 2T multi-pulse pattern table shown in FIG. 2 and FIG. 3 at s4 in the above flowchart, one of the multi-pulse patterns may be selected in accordance with a selection pattern as shown in FIG. 5, for example. More specifically, in (A) of this drawing, since ranges of recording speed are 1 to 4

times and 4 to 16 times in the low speed media and high speed media, the 1T multi-pulse pattern table is selected for disks produced by any manufacturer.

In the case of the ultra speed media, the 2T multi-pulse pattern table is selected for disks produced by any manufacturer, in recording at a recording speed beyond 20 times. However, in recording in the optical disk of the ultra speed media at 8 to 20 times recording speed, information other than the disk type information regarding the "ultra speed media" is referred, and whether or not to select the 2T multi-pulse pattern table even at this recording speed or to select the 1T multi-pulse pattern table in the range of this recording speed is decided.

[0025]

In this way, since it is possible to ensure that the semiconductor laser is turned on or off even in the high speed recording by applying the 2T multi-pulse pattern table, that is, the write strategy on a 2T cycle, the power of the laser light actually output from the semiconductor laser can be accurately controlled.

As shown in a jitter change graph and modulation degree change graph of FIG. 6(A) and (B) where recording is performed at 24 times speed, the optimum power in the high speed recording becomes about half of that on a 1T cycle if the write strategy is on a 2T cycle, thus providing such an advantage that a life of the semiconductor laser becomes longer. It also brings such an advantage that a low-powered

semiconductor laser and ALPC can be used.

[0026]

In this embodiment, two kinds of pattern tables on the 1T cycle and 2T cycle are stored in the memory 2 as the multi-pulse patterns (write strategy), but the cycles for the multi-pulse patterns are not limited to these. In addition, the kind is not limited to two either, and more kinds may be stored.

Furthermore, a multi-pulse pattern table is selected on the basis of both pieces of information regarding the disk type and recording speed in the flowchart of FIG. 4, but a multi-pulse pattern table may be selected on the basis of one piece of information regarding the disk type or recording speed.

[0027]

In addition, in the recording method such as CAV, partial CAV or zone CLV, recording speed changes during recording. In this case, the write strategy circuit 3 and the ALPC 2 change a clock cycle (T) or the write power in accordance with the change in the recording speed, but in addition to this, the multi-pulse pattern table set in the write strategy circuit 3 may also be changed.

More specifically, in this case, the control section 5 always monitors the change in the recording speed during recording, and continuously determines the optimum multi-pulse pattern table corresponding to the recording speed in accordance with the change in the recording speed. When the

optimum multi-pulse pattern table is switched to, this optimum multi-pulse pattern table is read from the memory 6 to be set in the write strategy circuit 3.

[0028]

Furthermore, the optical disk recording apparatus which records data in a CD-RW has been described in this embodiment, but the media are not limited to the CD-RW, and this invention can be applied to any media such as a PD as long as they are the media in which pits are formed by the multi-pulse method.

[0029]

[ADVANTAGES OF THE INVENTION]

As described above, according to this invention, a multi-pulse pattern table that is the optimum write strategy can be selected in accordance with the type of optical disk such as a CD-RW and recording speed, so that a good pit can be formed in any media and at any recording speed, and information can be recorded with good quality.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1] A block diagram of an optical disk recording apparatus according to an embodiment of this invention.

[FIG. 2] A diagram showing the content of a 1T multi-pulse pattern table applied to the optical disk recording apparatus.

[FIG. 3] A diagram showing the content of a 2T multi-pulse pattern table applied to the optical disk

recording apparatus.

[FIG. 4] A flowchart showing an operation of a control section of the optical disk recording apparatus.

[FIG. 5] A diagram illustrating how the optical disk recording apparatus selects a write strategy in accordance with a disk type and recording speed.

[FIG. 6] Graphs showing a jitter change and modulation degree change in a 1T-cycle write strategy and a 2T-cycle write strategy during high-speed recording.

[FIG. 7] A diagram illustrating a write strategy during conventional recording.

[Explanation of Reference Numerals]

1...optical system, 2...ALPC, 3...write strategy circuit, 4...encoder/decoder, 5...control section, 6...memory, 7...servo circuit, 8... disk type identification section, 9...spindle motor, 10...interface, 20...disk (CD-RW)

TRANSLATION OF THE DRAWINGS

FIG. 1

3: WRITE STRATEGY CIRCUIT

5: CONTROL SECTION

7: SERVO CIRCUIT

8: DISK TYPE IDENTIFICATION

FIG. 2, 3

UNIT OF LENGTH

FIG. 4

s1: SET BLANK DISK

s2: IDENTIFY DISK TYPE

s3: INPUT WRITE COMMAND

s4: SELECT MULTI-PULSE PATTERN TABLE

s5: SET MULTI-PULSE PATTERN TABLE

START RECORDING

FIG. 6(B)

MODULATION DEGREE

SEQUENCE

FIG. 7

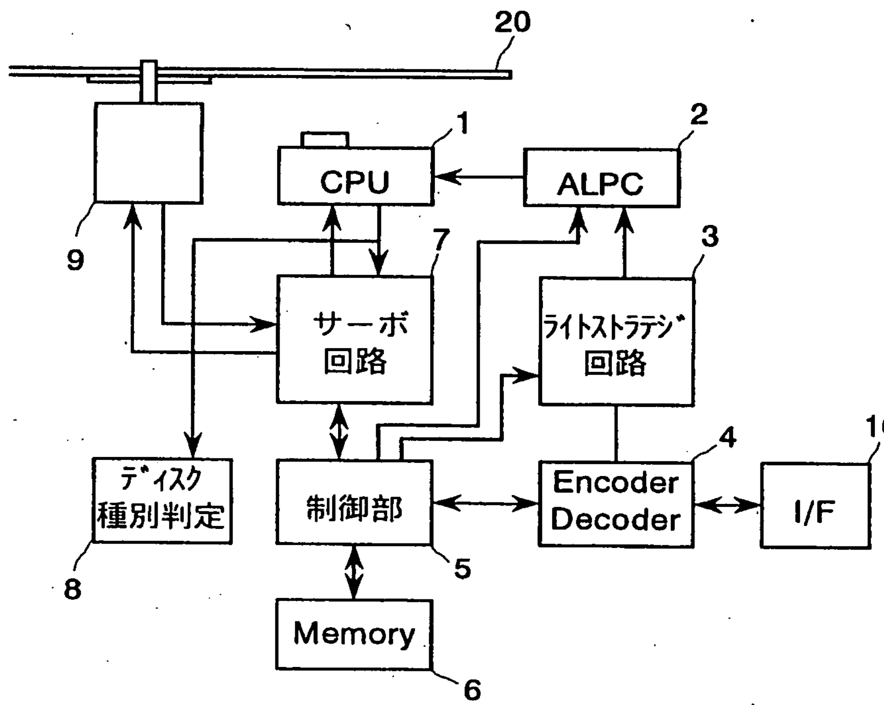
WRITE POWER

ERASE POWER

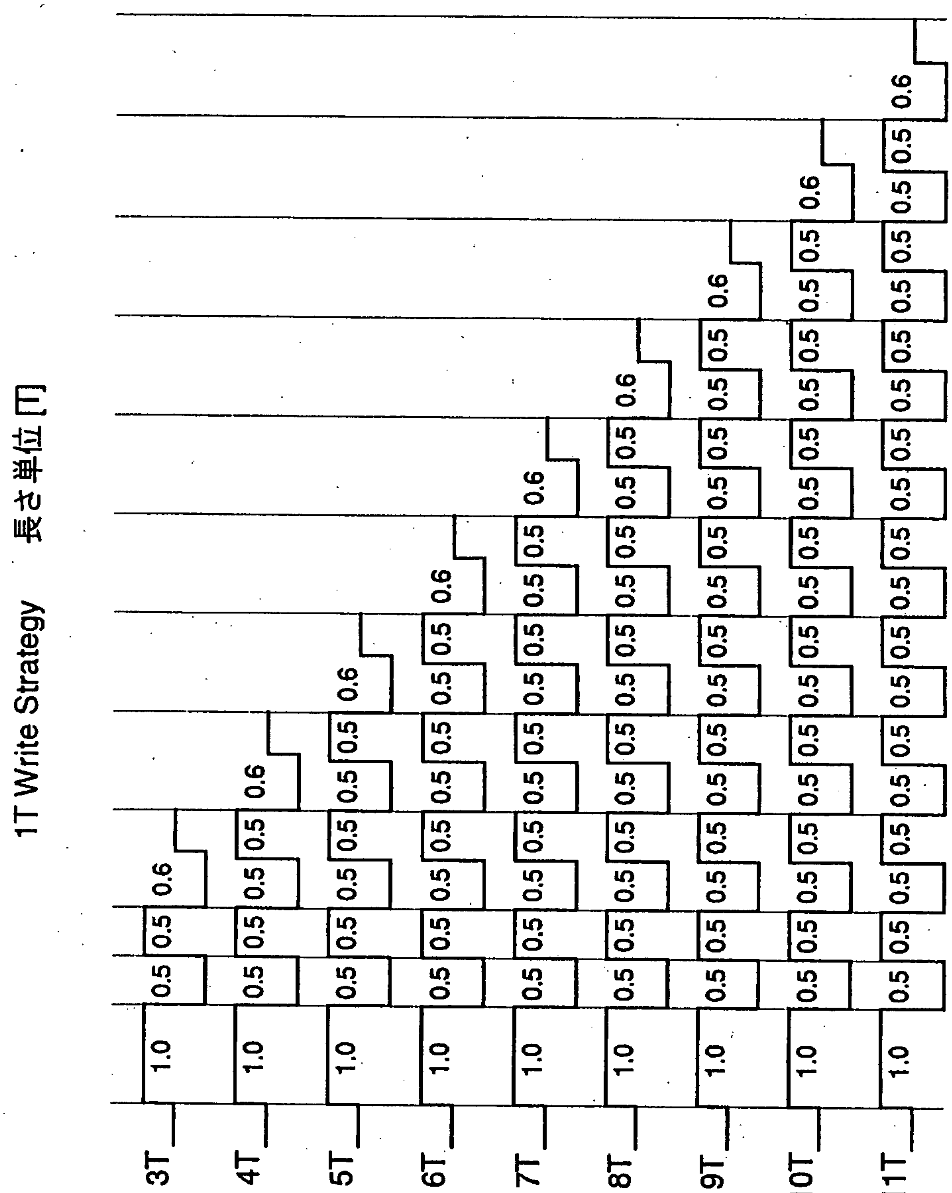
BOTTOM POWER

【書類名】　図面

【図１】


20
1
CPU
2
ALPC
9
7
3
サーボ
回路
ﾗｲﾄｽﾄﾗﾃｼﾞ
回路
4
10
ﾃﾞｨｽｸ
種別判定
制御部
Encoder
Decoder
I/F
8
5
Memory
6

【図２】



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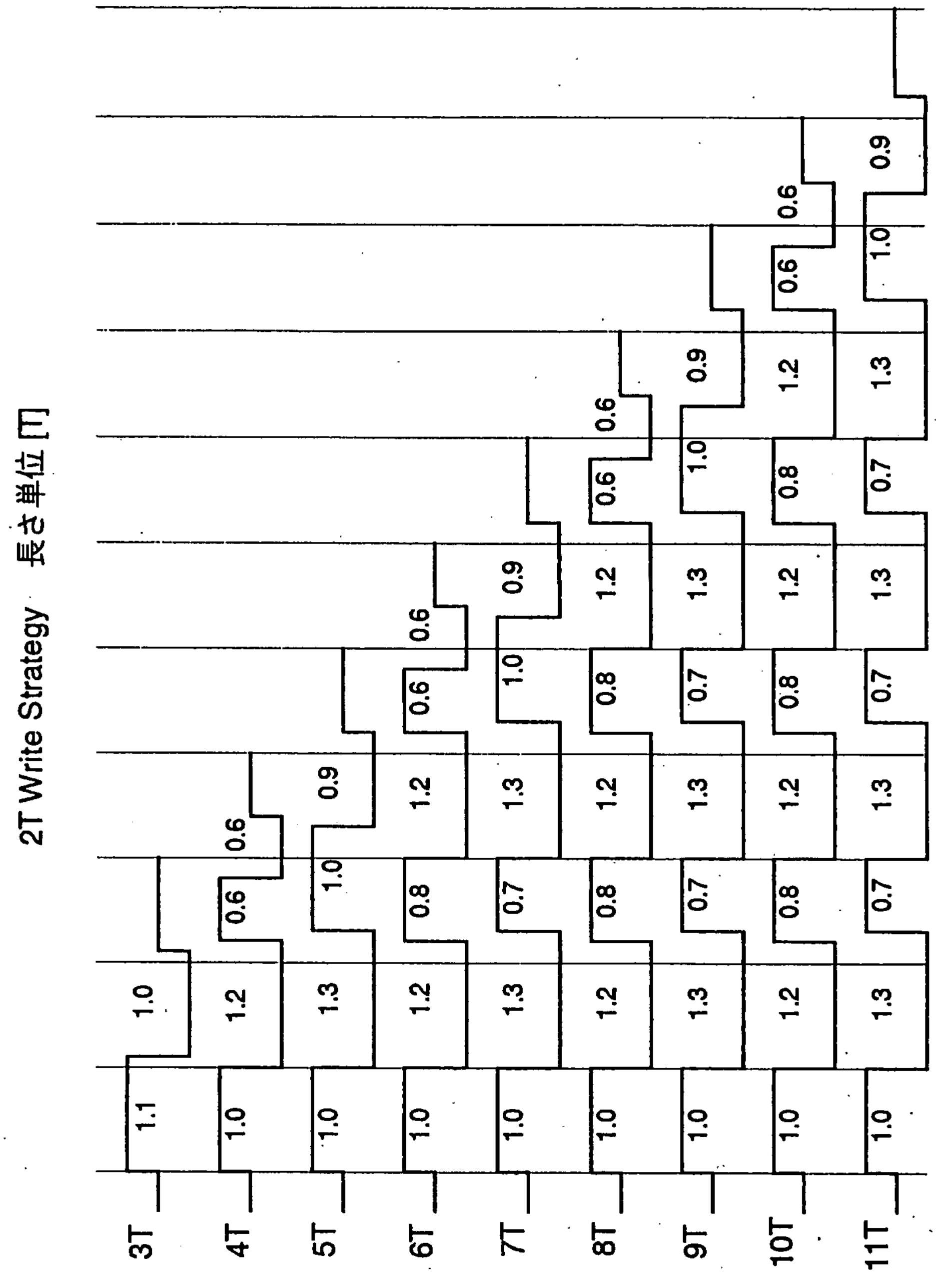

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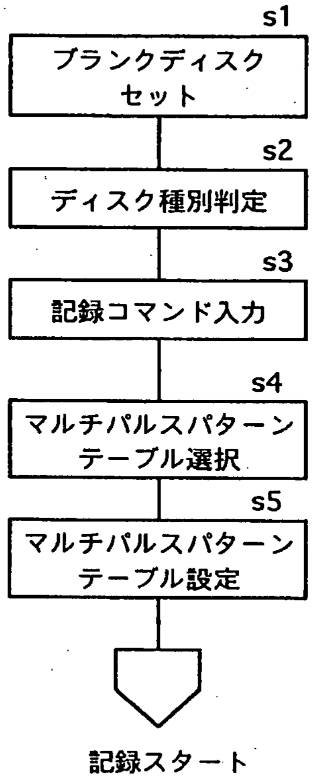
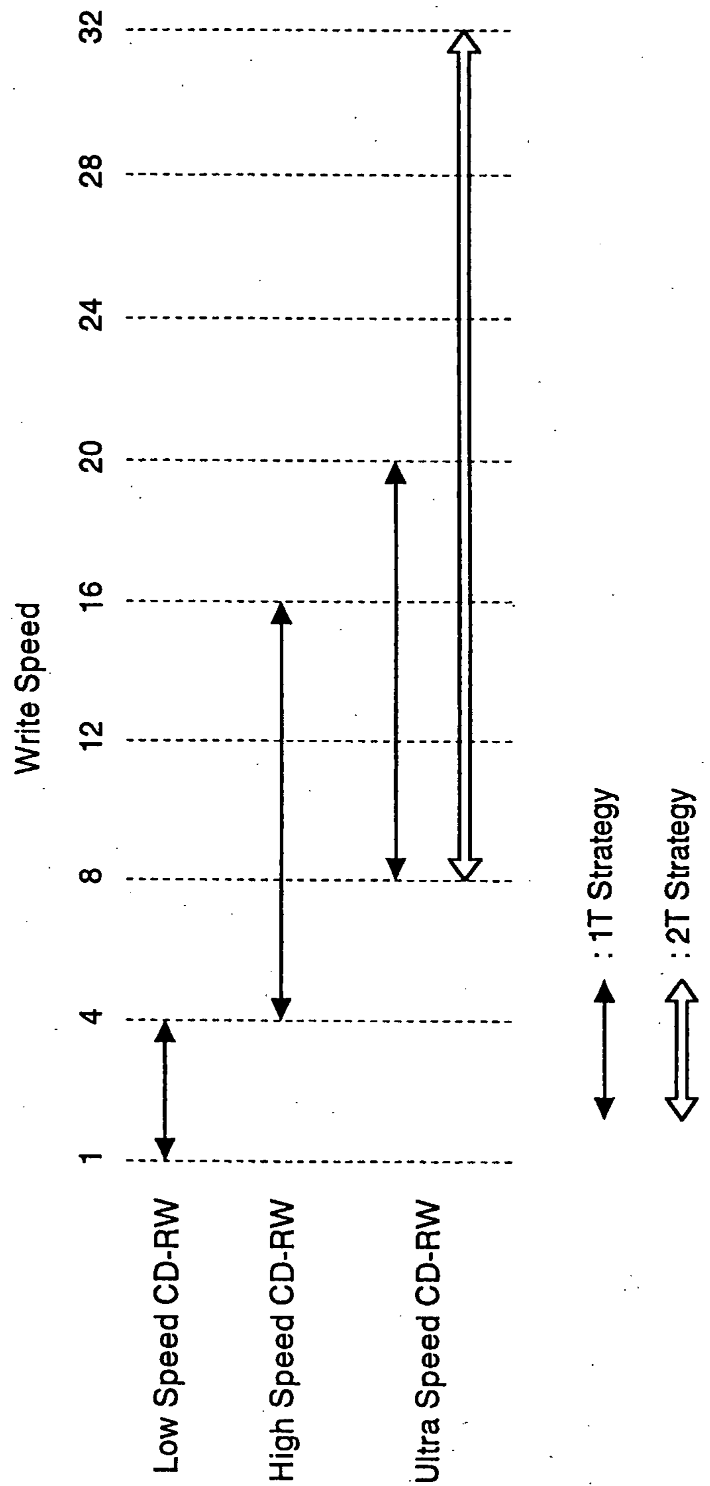
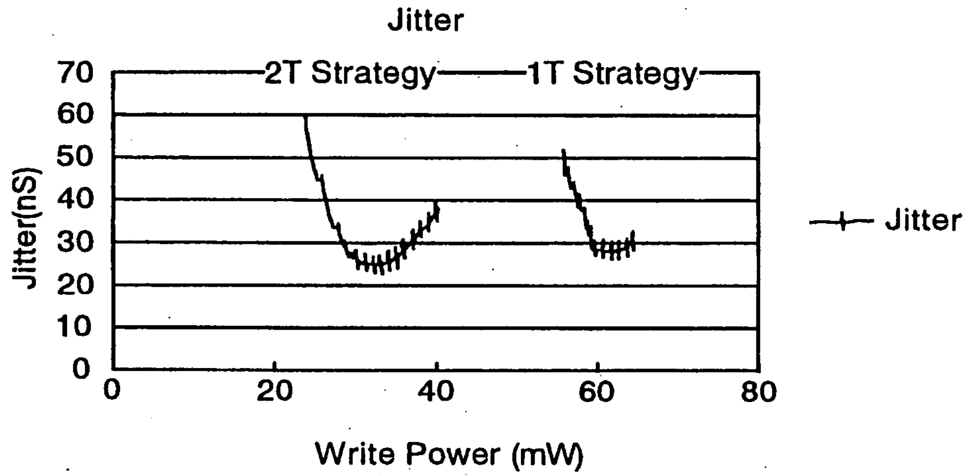

s1
ブランクディスク
セット
s2
ディスク種別判定
s3
記録コマンド入力
s4
マルチパルスパターン
テーブル選択
s5
マルチパルスパターン
テーブル設定
記録スタート

【図５】

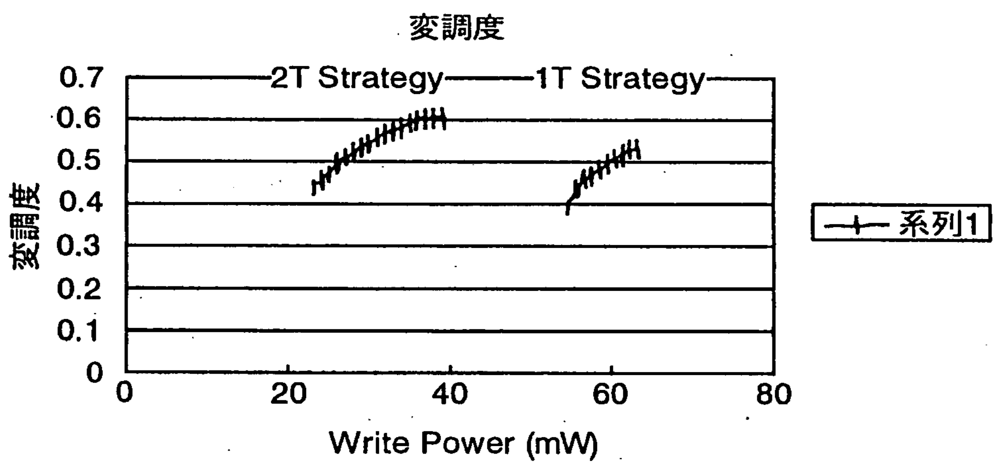

Write Speed
32
28
24
20
16
12
8
4
1
Low Speed CD-RW
High Speed CD-RW
Ultra Speed CD-RW
: 1T Strategy
: 2T Strategy

【図６】

(A)


Jitter
2T Strategy
1T Strategy
70
60
50
40
30
20
10
0
Jitter(nS)
0
20
40
60
80
Write Power (mW)
Jitter

(B)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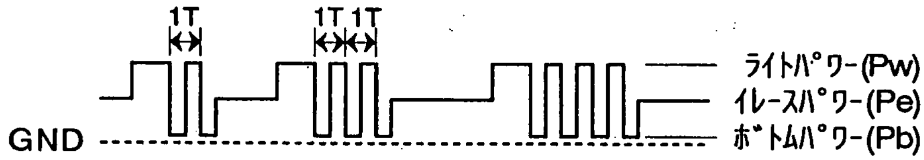
2T Strategy
1T Strategy
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
変調度
0
20
40
60
80
Write Power (mW)
系列1

【図７】

(A)



(B)